

CLAIMS

1. A liquid crystal display having a liquid crystal cell of bend alignment mode and a pair of polarizing plates provided on both sides of the cell, wherein at least one of the polarizing plates comprises a polarizing membrane and an optical compensatory film positioned nearer to the liquid crystal cell than the polarizing membrane, said optical compensatory film having at least two optically anisotropic layers comprising first and second optically anisotropic layers, said first optically anisotropic layer being made from discotic compounds oriented in hybrid alignment, said second optically anisotropic layer consisting of a cellulose ester film, and said polarizing membrane and said first and second optically anisotropic layers being so placed that the first optically anisotropic layer giving in plane the maximum refractive index in a direction of essentially 45° to a transmission axis in plane of the polarizing membrane, and that the second optically anisotropic layer gives in plane the maximum refractive index in a direction essentially parallel or perpendicular to a transmission axis in plane of the polarizing membrane, and wherein the liquid crystal cell of bend alignment mode and the first and second optically anisotropic layers have optical characters satisfying the following formula (1) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

$$(1) \quad 0.05 < (\Delta n \times d) / (R_{e1} \times R_{th2}) < 0.20$$

in which Δn is an inherent birefringent index of rod-like liquid crystal molecules in the liquid crystal cell; d is a thickness of a liquid crystal layer in the liquid crystal cell in terms of nm; R_{e1} is a retardation value in plane of the first optically anisotropic layer; and R_{th2} is a retardation value along a thickness direction of the second optically anisotropic layer.

2. The liquid crystal display as defined in claim 1, wherein the $\Delta n \times d$ satisfies the following formula (2) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

5 (2) $100 \text{ nm} < \Delta n \times d < 1,500 \text{ nm}.$

3. The liquid crystal display as defined in claim 1, wherein the R_{el} satisfies the following formula (3) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

10 (3) $10 \text{ nm} < R_{el} < 50 \text{ nm}.$

4. The liquid crystal display as defined in claim 1, wherein the R_{th2} satisfies the following formula (4) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

15 (4) $70 \text{ nm} < R_{th2} < 400 \text{ nm}.$

5. The liquid crystal display as defined in claim 1, wherein the optical compensatory film gives retardation values $Re(0^\circ)$, $Re(40^\circ)$ and $Re(-40^\circ)$ at 546 nm in the ranges of $30 \pm 10 \text{ nm}$, $50 \pm 10 \text{ nm}$ and $115 \pm 10 \text{ nm}$, respectively, and wherein $Re(0^\circ)$, $Re(40^\circ)$ and $Re(-40^\circ)$ stand for retardation values of the optical compensatory film when the retardation is measured, in a plane including the normal of the film and the direction giving in the film plane the minimum refractive index of the optical compensatory film, in the directions inclined at 0° , 40° and reversely 40° from the normal to the plane, respectively.

6. The liquid crystal display as defined in claim 5, wherein the direction giving in the film plane the minimum refractive index of the optical compensatory film is essentially at 45° to a longitudinal direction when the optical compensatory film is produced.

7. The liquid crystal display as defined in claim 1, wherein the optical compensatory film and the polarizing membrane are laminated by attaching the film in the form of a roll to the membrane in the form of a roll.

8. A liquid crystal display of reflection type having a reflection board, a liquid crystal cell of hybrid alignment mode and a polarizing plate in order, wherein the polarizing plate comprises a polarizing membrane and an optical compensatory film positioned nearer to the liquid crystal cell than the polarizing membrane, said optical compensatory sheet having at least two optically anisotropic layers comprising first and second optically anisotropic layers, said first optically anisotropic layer being made from discotic compounds oriented in hybrid alignment, said second optically anisotropic layer consisting of a cellulose ester film, and said polarizing membrane and said first and second optically anisotropic layers being so placed that the first optically anisotropic layer gives in plane the maximum refractive index in a direction of essentially 45° to a transmission axis in plane of the polarizing membrane, and that the second optically anisotropic layer gives in plane the maximum refractive index in a direction essentially parallel or perpendicular to a transmission axis in plane of the polarizing membrane, and wherein the liquid crystal cell of hybrid alignment mode and the first and second optically anisotropic layers have optical characters satisfying the following formula (5) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

$$(5) \quad 0.025 < (\Delta n \times d) / (R_{el} \times R_{th2}) < 0.10$$

in which Δn is an inherent birefringent index of rod-like liquid crystal molecules in the liquid crystal cell; d is a thickness of a liquid crystal layer in the liquid crystal cell in terms of nm; R_{el} is a retardation value in plane of the first optically anisotropic layer; and R_{th2} is a retardation value along a thickness direction of the second optically anisotropic layer.

9. The liquid crystal display as defined in claim 8, wherein the Δn_{xd} satisfies the following formula (6) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

$$(6) \quad 50 \text{ nm} < \Delta n_{xd} < 750 \text{ nm}.$$

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10. The liquid crystal display as defined in claim 8, wherein the R_{el} satisfies the following formula (7) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

$$(7) \quad 10 \text{ nm} < R_{el} < 50 \text{ nm}.$$

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11. The liquid crystal display as defined in claim 8, wherein the R_{th2} satisfies the following formula (8) when measured at any wavelength of 450 nm, 550 nm and 630 nm:

$$(8) \quad 70 \text{ nm} < R_{th2} < 400 \text{ nm}.$$

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12. The liquid crystal display as defined in claim 8, wherein the optical compensatory film gives retardation values $R_e(0^\circ)$, $R_e(40^\circ)$ and $R_e(-40^\circ)$ at 546 nm in the ranges of 30 ± 10 nm, 50 ± 10 nm and 115 ± 10 nm, respectively, and wherein $R_e(0^\circ)$, $R_e(40^\circ)$ and $R_e(-40^\circ)$ stand for retardation values of the optical compensatory film when the retardation is measured, in a plane including the normal of the film and the direction giving in the film plane the minimum refractive index of the optical compensatory film, in the directions inclined at 0° , 40° and reversely 40° from the normal to the plane, respectively.

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13. The liquid crystal display as defined in claim 12, wherein the direction giving in the film plane the minimum refractive index of the optical compensatory film is essentially at 45° to a longitudinal direction when the optical compensatory film is produced.

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14. The liquid crystal display as defined in claim 8, wherein the optical compensatory film and the polarizing membrane are laminated by attaching the film in the form of a roll to the membrane in the form of a roll.

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15. A method for testing an optical compensatory film having a transparent support and an optically anisotropic layer made from liquid crystal compounds, which comprises the steps of: placing the optical compensatory
10 film between a pair of Glan-Thompson prisms, positioning the film and the prisms so that light-transmittance may be the least, and measuring the light-transmittance to confirm whether the value defined by the following formula is smaller than a predetermined value or not:

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$$100 \times (T-C)/(P-C)$$

in which T is a light-transmittance measured where the optical compensatory film and the pair of Glan-Thompson prisms are positioned so that the light-transmittance may be the least; P is a light-transmittance measured where
20 only the Glan-Thompson prisms are placed in parallel Nicols arrangement; and C is a light-transmittance measured where only the Glan-Thompson prisms are placed in crossed Nicols arrangement.

25 16. The method as defined in claim 15, wherein the predetermined value is 0.005.

17. An apparatus for testing an optical compensatory film having a transparent support and an optically anisotropic layer formed from liquid crystal compounds, which comprises a light source, a pair of Glan-Thompson
5 prisms, a holder with which the optical compensatory film is kept and placed between the Glan-Thompson prisms, a mechanism rotating the Glan-Thompson prisms independently around the light path, and a light-receiver by which light having been emitted from the light source and passed
10 through the optical compensatory film and the Glan-Thompson prisms is detected and evaluated.

18 The apparatus as defined in claim 17, wherein the apparatus further comprises another mechanism rotating
15 the optical compensatory film around the light path.